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PRELIMINARY TERMS OF REFERENCE (TOR) AND ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF GEOTHERMAL EXPLORATION DRILLING IN BUGARAMA, RWANDA

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ABSTRACT

Surface exploration studies for the Bugarama area were launched in 2014. Drilling is required to prove the existence of a geothermal resource. This report is based on experience accumulated during exploration drilling in Karisimbi in 2013, and on ESIA studies carried out for geothermal drilling projects in Rwanda. The first goal is to draw up the main procedures that must be followed during preparations for geothermal drilling, in order to ensure compliance with national and international regulations. Next is to present the preliminary terms of reference (TOR) for the ESIA that will be conducted during preparations for exploration drilling in Bugarama. Finally, a preliminary EIA of the three main environmental factors that the project is expected to impact i.e. noise, land acquisition and waste generation, is introduced. Mitigating measures are proposed for the mentioned impacts. The aim of this report is to provide a basis for future EIA work for geothermal exploration drilling in Rwanda. The main outcomes for a full EIA study are discussed.

1. INTRODUCTION

Rwanda is a landlocked country in East Africa, located along the Western Branch of the East African Rift system, with a surface area of 26,338 km², and a population estimate of 10.5 million inhabitants (NISR, 2012).

The Government of Rwanda has put emphasis on all developmental sectors to ensure a green economy in Rwanda. In fact, the protection of the environment and sustainable natural resource management are the cross-cutting areas of Rwanda Vision 2020, and the Economic Development and Poverty Reduction Strategy (EDPRS) Phase II, which was launched September 2013, with the following goals (MINECOFIN, 2000 and 2012):

“Sustain rapid economic growth and facilitate the process of economic transformation by increasing the internal and external connectivity of the Rwandan economy.

This will be achieved through improved infrastructure, exports, and more integrated supply chains, while meeting demand in the energy sector, planting the seeds of a green economy, and better managing the process of urbanisation."

The main imperatives of the Energy sector are efficient use of energy, rationalizing energy pricing and subsidies, institutional development of the sector, and capacity building (AfDB, 2013), consequently financially supporting and focussing on renewable and environmentally friendly sources of energy such as hydropower, solar, and geothermal energy.

Geothermal research in Rwanda started in the 1980s and indicated the presence of a geothermal resource; two exploration areas have been identified, shown in Figure 1. The first area (Gisenyi, Karisimbi, and Kinigi) in the northwest region is associated with volcanoes; the second area (Bugarama) in the southwest region is associated with faults in the East African Rift, shown in Figure 2. Exploration for geothermal energy in the Karisimbi area culminated with drilling in July 2013, to prove the existence of a resource on the slope of the Karisimbi volcano. Even though the drilling was not successful, the research for geothermal energy in Rwanda carried on in the southwest region in the Bugarama area. In fact, reconnaissance surveys and surface exploration started in 1982 with the French Bureau of Geology and Mines (BRGM), but detailed surface studies were not launched until 2014. The geothermal areas to be investigated are located near the joint border between Burundi, RDC and Rwanda in the Bugarama area, and will be confirmed by exploration drilling.

A lot has been learned about the main environmental concerns of drilling activities, and from studies on the environmental and social impacts of geothermal drilling activities at Karisimbi and Kinigi. The purpose of this report is to best prepare for an environmental impact assessment (EIA) of the proposed exploration drilling in the geothermal area in Bugarama by preparing a preliminary TOR, along with a draft of an EIA on three of the main environmental factors that drilling would affect. EIA is a procedure used to examine the environmental consequences or impacts, both beneficial and adverse, of a proposed developmental project and to ensure that these effects are taken into account in project design. The EIA is, therefore, based on predictions. These impacts can include all relevant aspects of the natural, social, economic and human environment (Ogola, 2007).

This report is structured as follows. The main environmental laws and regulations required to gain consent for exploration drilling in a geothermal area are listed. Then the preliminary TOR is prepared and presented, following the EIA law in Rwanda and the World Bank guidelines. This section captures the main environmental factors/issues in Bugarama that need to be studied and dealt with in an EIA. In the last chapter, a draft of the EIA is presented with a particular focus on three key environmental factors that geothermal exploration activities in Bugarama can, and probably will, impact, including necessary mitigating activities.

2. ENVIRONMENTAL LAWS AND REGULATIONS IN RWANDA

2.1 Environmental laws and regulations

Here, the environmental laws and regulations in Rwanda are presented, along with decrees, statutory instruments and ministerial orders which deal with environmental protection. It also includes other laws and regulations that require consent for exploration drilling.

These are presented here in an attempt to inform developers at an early stage about the legal system in Rwanda and how they must prepare if they are planning extensive use of geothermal power.



FIGURE 1: Geothermal areas in northwest and southwest Rwanda (modified from JICA, 2013)

The first policy on environment protection and management was formulated in the Rwanda Constitution in 2003, followed by Organic Law n° 04/2005, establishing the Modalities of Protection, Conservation and Promotion of the Environment (Articles 67, 68, 69, and 70). Rwanda Environment Management Authority (REMA) is based on this law as is the definition of the responsibilities of involved stakeholders.

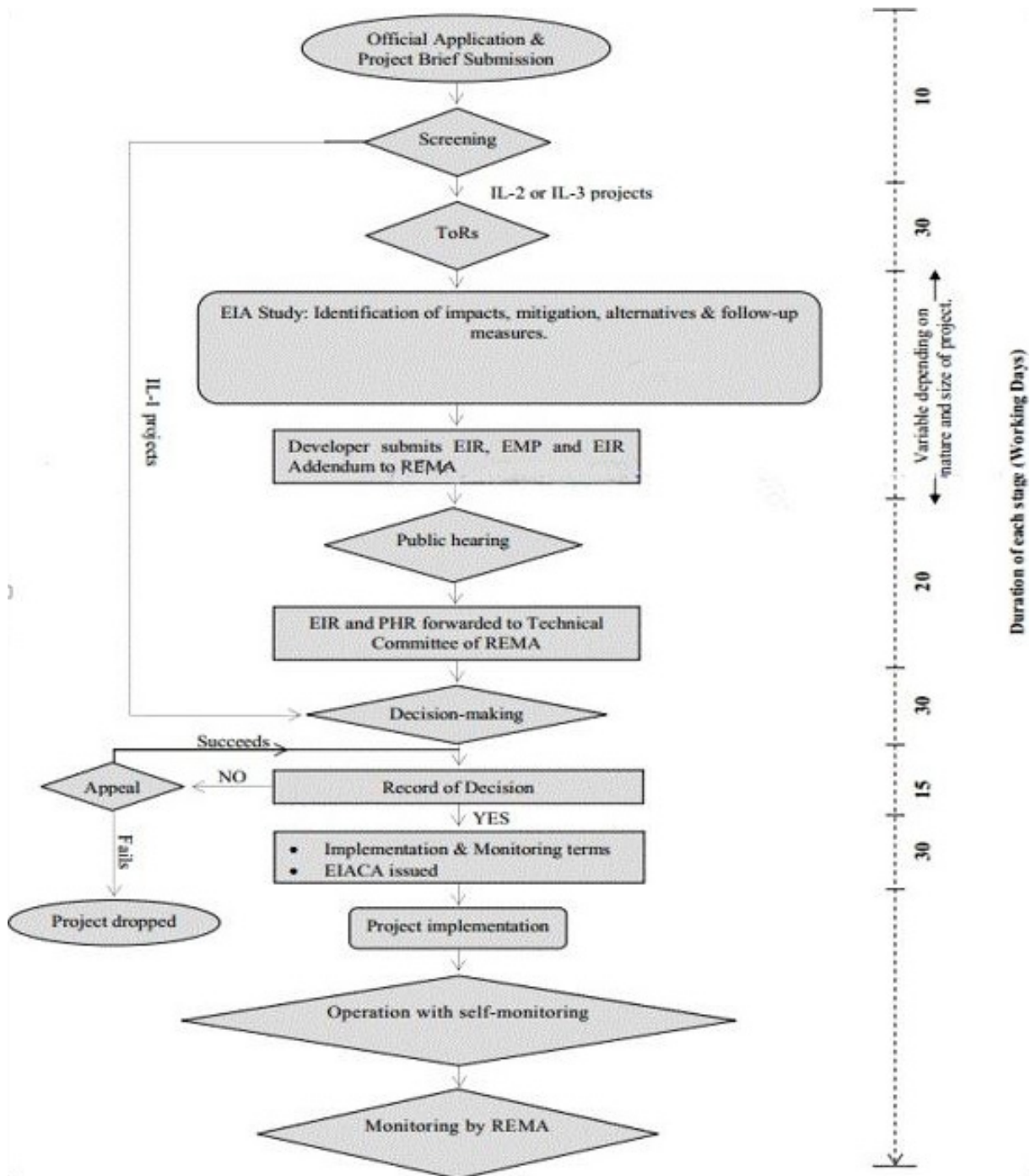


FIGURE 2: EIA procedure flowchart (from REMA, 2006)

National strategies and programs have been made to support the development of the country and take into account sustainable environmental and natural resource management, such as Rwanda Vision 2020, and The Economic Development and Poverty Reduction Strategy (EDPRS), which aims to reduce poverty through a pro-poor national growth agenda. Therefore, multiple laws and ministerial orders on social protection, land use, waste and environment management must be adhered to.

Laws and regulations are listed in Tables 1-4; their relevance to geothermal exploration activities must be noted in order to ensure that projects are in compliance with national regulations. In addition, Table 5 gives a list of the permits that geothermal drilling project require.

TABLE 1: National strategies

- Rwanda Vision 2020, 2000
- Rwanda constitution, 2003
- National Poverty Reduction Strategy, 2008
- Economic Development and Poverty Reduction Strategy (EDPRS) phase II, 2013
- The five year strategic plan for the environment and natural resources 2009-2013, 2008

TABLE 2: National policies

- Rwanda Environmental Policy, 2003
- The Mines and Geology Policy, 2004
- The National Land Policy, 2004
- The Water and Sanitation Policy, 2004
- Rwanda Land Policy, 2004
- Rwanda Health Sector Policy, 2005
- Rwanda Agricultural Policy, 2008
- Rwanda Water and Sanitation Policy, 2010
- National Forestry Policy, May 2010
- National Water Resources Management Policy, 2011

TABLE 3: Organic laws

- The Law on Forestry No 47/1988 of 5 December 1988
- The Land Act, 2004
- The Organic law determining the modalities of Protection, Conservation and Promotion of Environment in Rwanda No 04/2005
- The Organic law determining the Use and Management of land in Rwanda No 08/2005
- Presidential Order determining the structure, the responsibilities, the functioning, and the composition of Land Commissions No. 54/01
- The Land Valuation Law, promulgated in 2007
- The Land Expropriation Law promulgated No. 18/2007
- The Water Law No 62/2008

TABLE 4: Ministerial orders

Environment

- Ministerial Order relating to the requirements and procedure for environmental impact assessment No 003/2008
- Ministerial Order establishing the list of works, activities and projects that have to be undertaken in an environment impact assessment No 004/2008
- Ministerial Order establishing modalities of inspecting companies or activities that pollute the environment No 005/2008
- Ministerial Order regulating the importation and exportation of ozone layer depleting substances, products, and equipment containing such substances No 006/2008
- Ministerial Order establishing the list of protected animal and plant species No 007/2008

Land Use

- Ministerial Order determining the structure of Land Registers, the responsibilities and the functioning of the District Land Bureau No 001/2006
- Ministerial order determining the Land Title and Registration Law No 002/2008

Social

- Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees No 01/20012

TABLE 5: Rwandan National Permit requirements (MML, 2013)

General construction permits required	Issuing authority	Comments
Approval on the terms of reference	RDB	Required under EIA general guidelines, 2006
EIA Implementation Order	RDB	Required under EIA general guidelines, 2006
EIA Certificate of Authorisation	RDB	Environmental organic law, 2005 and EIA general guidelines, 2006
Liquid wastes disposal and treatment	Rwanda Utilities Regulatory Agency (RURA)	Required under law No 39/2001 establishing RURA and the Directive on minimum requirements for liquid wastes disposal and treatment, 2009
Management of waste disposal site	RURA	Standards On The Management Of Waste Disposal Site, 2009
Construction Permit	District level approval	Law governing urban planning and building in Rwanda, 2012
Water permit	Ministry of Natural Resources (MINIRENA)/Rwanda Natural Resources Authority (RNRA)	Law for the use, conservation, protection and management of water resources, 2008

2.2 International agreements and requirements

When preparing a major geothermal exploration project, the authorities of the country involved must take into account several international agreements. In most countries, laws on EIA exist and are founded partly on Multilateral Environmental Agreements (MEAs), such as:

- The Espoo (EIA) Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries. The Convention was adopted in 1991 and entered into force on 10 September 1997 (UNECE, 1991).
- The Rio Declaration (1992) was adopted to be a tool in the national decision making process during assessment of the environmental impacts of a project. The goal was to establish a new and equitable global partnership through the creation of new levels of co-operation among States, key sectors of societies and the public. In Europe, the laws and regulations on EIA and SIA are based on European Union (EU) directives and, in the USA, the Environment Protection Agency (EPA) has developed (EIA) Technical Review Guidelines for different sectors like energy (EPA, 2014).

Both EU directives and EPA guidelines are widely used as models for EIA laws and regulations around the world. In addition, it is well known that projects must comply with requirements from international banks if a project is to be funded by them. Investment banks like African Development Bank (AfDB), European Investment Bank (EIB), Japanese Bank for International Cooperation (JBIC) and, last but not least, the World Bank (WB) have environmental safeguards to ensure that financing of projects is not only based on the precautionary principle and preventative actions rather than mitigations, but also on sustainable development.

For instance, World Bank Operational Policy 4.01 on Environmental Assessment classifies projects into specific categories. Environmental screening projects are classified into four categories depending on

the type, location, sensitivity and scale of the project and the nature and magnitude of its potential environmental impacts:

- **Category A:** A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the 'without project' situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. The borrower is responsible for preparing a report, normally an Environmental Impact Assessment (EIA) (or a suitably comprehensive regional or sectoral EA) that includes, as necessary, elements of the other instruments referred to in Paragraph 7 of Operational Policy 4.01.
- **Category B:** A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas, including wetlands, forests, grasslands, and other natural habitats, are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; in most cases, mitigating measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of a Category A EA. Like a Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. The findings and results of a Category B EA are described in the project documentation (Project Appraisal Document and Project Information Document).
- **Category C:** A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.
- **Category FI:** A proposed project is classified as Category FI if it involves investment of bank funds, through a financial intermediary, in subprojects that may result in adverse environmental impacts (WB, 1999).

The World Bank published guidelines regarding resettlement, which are widely used as a baseline in many countries. Note World Bank Operational Policy 4.04-Natural Habitat and the policy on Involuntary Resettlement/Relocation and Compensation of People, World Bank WB OP/BP 4.12.

2.3 EIA framework in Rwanda

The policy and the legal framework for an EIA were first found in the constitution of the Republic of Rwanda in 2003. Organic law No 04/2005, in determining the modalities of protection, conservation and promotion of the Rwandan environment, made Environmental Impact Assessment (EIA) mandatory for approval of many development projects, before implementation.

The objectives of the EIA in Rwanda are to identify adverse environmental consequences at an early stage, propose a way of avoiding negative impacts and, if that is not possible, propose mitigating measures and facilitate the decision making at the planning and design phase of the project. The findings of the EIA are a useful tool for project authorization and monitoring during construction, operation and demolition. Therefore, the general guidelines and procedures for an EIA were published in November 2006 to serve as a protocol for various stakeholders involved in the EIA process.

The governmental institution in charge of the environmental and social impact assessment (ESIA) process is the Rwanda Environment Management Authority (REMA), established by Organic law No. 04/2005. It shall coordinate and oversee all aspects of environmental management for sustainable development.

Some of the responsibilities are shared with the Rwanda Development Board (RDB). All applications for the EIA authorization certificate take place at RDB as it is the one stop place for investors (RDB, 2014). REMA is in charge of coordination, monitoring and supervision of all activities related to environmental protection.

According to the EIA Guidelines in Rwanda and Ministerial order N° 003/2008, the EIA process in Rwanda can be presented in the following steps:

a. Application and registration

In the first step of the EIA process, the developer submits an application for an EIA of a proposed project to REMA in the form of a brief introduction of the project, according to EIA Regulations. This introductory paper goes through a screening process.

b. Screening

Screening is carried out by REMA to determine the impact level of a proposed project which, in turn, determines the extent of the EIA study. Based on information in the Project Brief, REMA determines whether or not an EIA is required and the developer is accordingly notified. Screening enables early identification of environmental issues of major concern and the incorporation of appropriate mitigating measures. Screening also enables categorisation of projects according to their Impact Level (IL), as follows: IL 1: Projects not requiring further environmental analysis; IL 2: Projects not requiring a full EIA but necessitating a further level of assessment; IL 3 Projects require a full EIA.

c. Scoping and Terms of Reference

Scoping is the initial step of the Environmental Impact Study phase and involves input from relevant Lead Agencies, stakeholders and the developer in order to obtain their comments on what should be included in the study, and what alternatives should be considered. Scoping is a necessary step in the formulation of a detailed TOR for the impact assessment that will be done by the developer. The TOR sets objectives, defines the scope, and establishes the applicable strategy and methodology that shall be used to describe and assess the environmental impacts of the planned exploration drilling. TOR ensures that important issues are not overlooked by the EIA Experts and developers during EIA studies. The scoping report is submitted to REMA for review.

Within thirty (30) calendar days after receipt of the project brief and its analysis, the Authority shall submit the Terms of Reference to the developer for the Environmental impact study.

d. Environmental Impact Study, Assessment and Report

The Environmental Impact Study phase is the investigative stage of the EIA process; for this, a developer hires EIA experts. This phase begins when a developer selects expert(s) from a list of EIA experts provided by REMA. Within a period of five (5) working days after reception of the proposed experts, REMA will notify the developer of its acceptance or refusal of the proposal. The developer and EIA experts shall work together throughout the EIS phase to gather the necessary information on the environment and society, assess the project's impacts and develop adequate measures to mitigate negative impacts and enhance positive ones. An Environmental Impact Report (EIR) shall also include An Environmental Management Plan for the project.

e. Report review, and decision-making

After reserving the EIA report (or EIS) from the developer and his expert, REMA (the Authority) shall, within twenty (20) working days, accept the report or request additional information from the developer. Review of an EIA report submitted to REMA, enables subsequent decision-making on either approval or disapproval of a project. Depending on the nature of the project, the time limits mentioned above may be extended.

f. Project decommissioning/demolition or relocation

Upon project completion or when seeking relocation, a developer should prepare a decommissioning plan and submit it to REMA for approval. The decommissioning plan should include, but not be limited

to: assessment, existing environmental conditions, all proposed engineering works, mitigation activities associated with the removal of project facilities, and proposed restoration measures in the project area.

All the above mentioned steps are detailed in the General Guidelines and procedures for an Environmental Impact Assessment, published by REMA (the Rwanda Environment Management Authority) in November 2006.

3. PRELIMINARY TERMS OF REFERENCE (TOR) FOR THE EIA STUDY OF GEOTHERMAL EXPLORATION DRILLING IN BUGARAMA

The EIA process is a prerequisite to successful implementation of the project. The TOR outlines the EIA process that a developer must go through before consent for the exploration drilling can be given. Specifically, the TOR sets objectives, defines the scope, and establishes the applicable strategy and methodology that shall be used to describe and assess the environmental impacts of the planned exploration drilling. The TOR is a description of what must be included in the EIA report, how information shall be gathered and how the results shall be described in the report.

The EIA shall be prepared according to environmental procedures, laws and regulations of the Government of Rwanda and be consistent with the World Bank standards on EIA.

3.1 Background information

One of the energy sector's mandates in Rwanda is to establish environmentally sound and sustainable systems of energy production, procurement, transportation, distribution and end-use (AfDB, 2013). The Government of Rwanda (GoR) envisages increasing access to electricity and diversifying energy sources and is, thus, putting huge efforts into the diversification of energy sources in line with this diverse development of the country.

In fact, like in many other energy projects, geothermal exploration studies, from surface studies to drilling, were first fully funded by the GoR. The purpose of geothermal exploration is to prove the existence of a viable and renewable source of energy that can be economically utilised for electricity generation and/or direct use, thus contributing to the development of the country.

The geothermal exploration and development are managed by the geothermal development unit in the Rwanda Energy Group, which is in the Energy Development Company (Previously called Energy Water and Sanitation Authority) under the Ministry of the Infrastructure.

Environmental and Social Impacts Assessment Studies have been done for geothermal exploration drilling projects in Karisimbi and Kinigi areas in North Rwanda. According to the EIA guidelines in Rwanda, the projects were classified as category IL 3, requiring a full EIA as they were considered to have adverse environmental impacts where sufficient mitigations could not be prescribed (REMA, 2006). The ESIA studies resulted in both areas being put in category A (referring to World Bank guidelines), meaning that geothermal exploration drilling activities would negatively affect an area broader than the communities benefiting from the projects/infrastructure.

Surface studies are ongoing in the Bugarama area. The next step in the research of the area is to drill an experimental well in order to verify that there is usable energy.

More background information can be obtained from previous EIA study reports, as well as geoscientific surveys carried out for geothermal exploration in Rwanda.

3.2 Bugarama geothermal area

Exploration of geothermal resources in Rwanda began in the western (Gisenyi, Kibuye and Kinigi) and southern (Bugarama) regions of Rwanda in 1982, with the French Bureau of Geology and Mines (BRGM), and identified Gisenyi and Bugarama as potential sites for geothermal energy with estimated reservoir temperatures of over 100°C. No other geothermal survey has been conducted to confirm this.

In 2013, tendering procedures for a reconnaissance and geoscientific survey for the Bugarama area were completed. They were financed by the European Union in collaboration with the Icelandic International Development Agency (ICEIDA). The study was conducted in the Rusizi region which is shared by the Democratic Republic of Congo, Burundi and Rwanda. The scope of the work is to define the potential resource temperature, the geologic structures controlling the geothermal activity and the extent of the geothermal resources. The exploration study will conclude with a proposed drilling site for a deep (1400 to 1800 m) exploration well (Rusizi, 2013).

Bugarama geothermal area is located approximately 13 km southeast of the town of Cyangugu in the Rusizi district in the Western Province. It is located in a region of moderate altitude (900 m-1500 m). The Rwanda Meteorology Services reported that the highest temperatures in the country are found in Bugarama Valley (annual mean 23 - 24°C).

The region is mainly known for agriculture, based on rice and maize, and commerce activities with the neighbouring Democratic Republic of Congo.

The Bugarama geothermal area is well known from manifestations in the form of hot and warm springs and travertine deposits (Figures 3 and 4), which are mined and used as raw materials for a nearby cement factory.

The Mashyuza hot spring is a tourist attraction, where local communities and tourists come for bathing as the geothermal water is considered to be healthy or to have therapeutic effects.

The temperature of the water was measured by the geochemistry team from the geothermal development unit (GDU) in 2012 and was found to be 57°C.



FIGURE 3: Travertine deposits at Mashyuza hot springs (From GDU, 2012)



FIGURE 4: Mashyuza hot spring (Source, GDU)

3.3 Area of influence

The goal of the EIA is to identify the environmental factors that the project will impact, the extent of the impacts, their importance and the need to change the project to minimize negative impacts or find mitigations. The size of the area that will be affected by the project may not be clear in the beginning

and may vary, depending on the different affected environmental factors, for instance, the nuisance of noise that will come from construction, drilling and testing, plus the impact on the biodiversity, such as migrating animals, will extend the area of influence. There is currently no master plan in the district; however, the following map (Figure 5) does show the main land use in the area, such as the agricultural area, forests roads and villages. The rice farms are located along the rivers in the marshlands in the Bugarama Valley. A few geological structures, Mashyuza hot springs, and Bize are also marked.

Additional information about the area, such as maps of geological features or geophysical maps, have not been published, and the proposed location options for drilling sites have not been defined yet. In the final TOR, this information must be available on maps, at a scale of 1:5,000-1:20,000, as a basis for studies on different environmental factors, along with the master plan of the region and photographs.

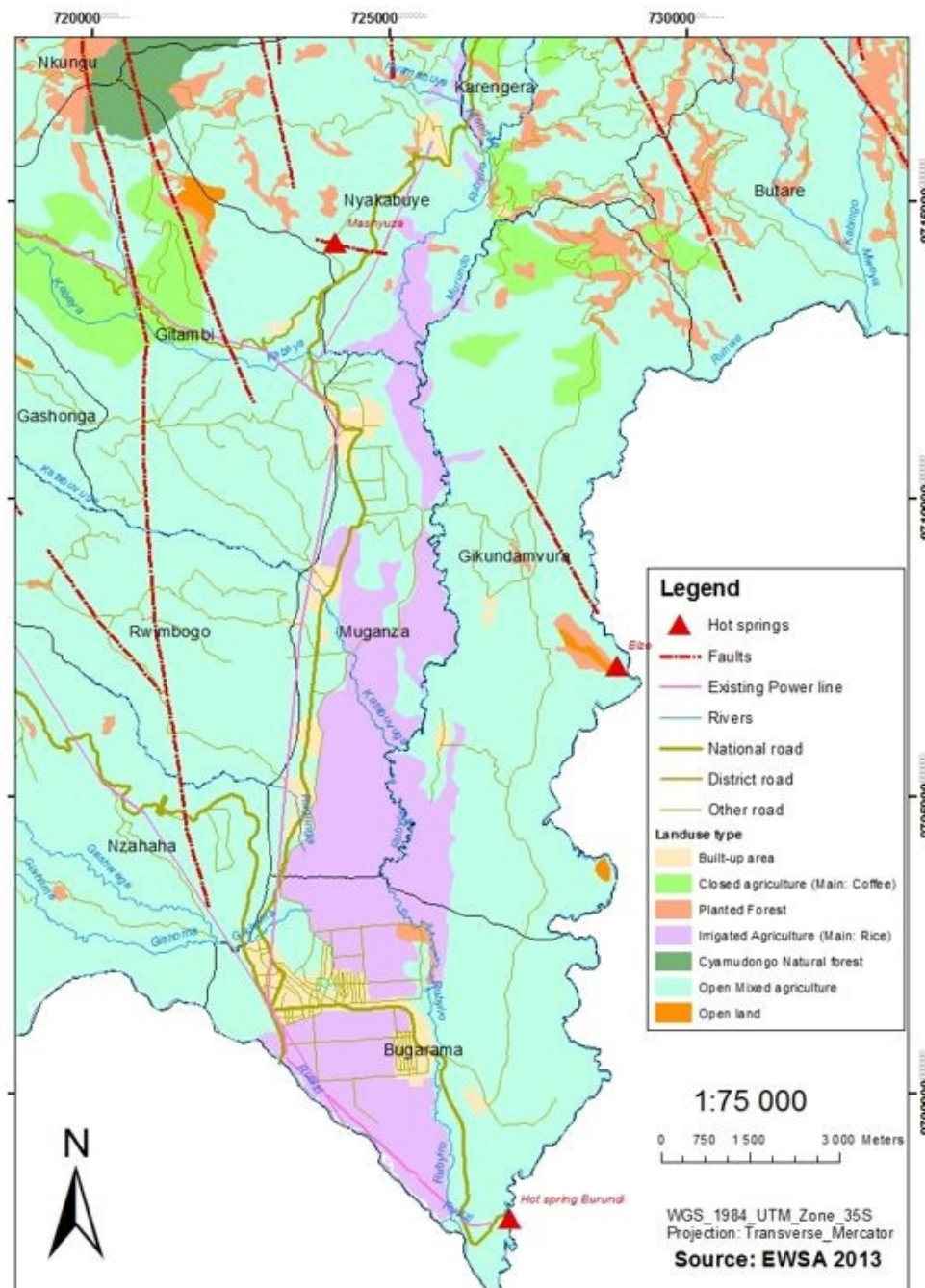


FIGURE 5: Land use map of Bugarama area

3.4 Description of the geothermal drilling exploration project

The scope of the planned exploration drilling is to define the potential resource temperature, the geologic structures controlling the geothermal activity, and the extent of the geothermal resource (Figure 6).



FIGURE 6: Karisimbi geothermal exploration drilling project, July 2013

The main components of the project in each construction area are:

- New roads and/or reconstruction of existing roads for the transport of machinery, and materials for the drilling activities;
- Drilling platform, from the standards used for Karisimbi geothermal drilling, the platform includes a settling pond for water disposal and space for the heavy machinery and offices, minimum size 3-6.000 m²;
- Water supply system comprised of water tanks, water supply pipelines and pumping houses; and
- Workers' accommodations and material storage yard.

In Table 6, the main project components and expected duration of the work in months are described

TABLE 6: Exploration drilling components and duration of construction/activities

Project component	Size (m×m)	Duration
Reconstruction and construction of access road	6 m width, length unknown	6 months
Construction of water pipeline, tanks and pump houses	Not known	6 months
Construction of campsite storage yard	100×35	4 months
Construction of storage yard	100×65	4 months
Site clearance of 3 drilling pads	150×85	5 months
Rig mobilization	-	1 month
Drilling activities of 3 wells	-	6 months

*Size and duration of activities is based on estimates/experience from the Karisimbi geothermal project and could be different for the Bugarama project. Most of the components in Table 6 are done simultaneously which considerably reduces the time of the whole project.

3.5 Objectives and requirements of the EIA study

The main objectives of the EIA are to:

- Ensure that the project is in accordance with laws and regulations in Rwanda;
- Compile the ecological and socioeconomic baseline conditions of the project area in Bugarama and the local communities that might be affected by the exploration drilling;
- Identify impacts of the project on the local community and how to make them as positive for the community as possible;
- Assess in detail the environmental, social, and health impacts that would result from the project;
- Inform and obtain input from stakeholders, (e.g. governmental authorities, the public, and local communities) and take into consideration their comments and concerns; and
- Develop an Environmental and Social Management Plan (ESMP) with mitigating measures resulting from the EIA.

The EIA study must: meet the requirements or recommendations of the applicable national and international regulations and standards; be guided by the policies, guidelines, and procedures of the relevant international treaties and agreements relevant to geothermal developmental activities.

The EIA should also follow the environmental assessment regulations of any other financing organizations involved in the project, and relevant international environmental agreements/conventions to which the country is part of, such as the World Bank Operational Policies (ArGeo EIA Framework, 2009).

The environmental factors that will be included in the EIA are chosen because of the impacts that the project is expected to have on the environment. The construction of roads and platforms, campsites and gravel mining will result in changes on the surface and include traffic. This can affect geological formations, soil and vegetation, landscape and visual values, historical monuments, housing and tourism. Also, the drilling operations will create noise and traffic that will be a nuisance to the people living in the area and to tourists.

With regard to this, the EIA will consider the project's impacts on the following environmental factors: Land use and conservation, water resources, noise, air quality, biodiversity, social aspects, solid wastes, natural hazards, tourism, geology, landscape and visual impacts. The EIA will deal with the impacts during construction, operation and demolition.

3.6 Scope of work of the EIA study

Basically, the EIA process consists of a baseline study describing the environment before the project starts. It assembles and evaluates the baseline data on the physical environment (geology, topography, soils, etc.), biological environment (flora, fauna, natural sites, etc.) and, finally, the socio-cultural environment in the area (population, land use and planned activities in the area). Based on the baseline information, the EIA must predict the magnitude, the extent and the duration (short or long term) of the potential impacts, whether the impacts are irreversible or reversible, and the size of the impact area. Then mitigating measures that the developer has decided to use are introduced and the applicable cost is evaluated.

The team for the EIA should include, but not be limited to, experienced specialists in the following areas:

- Meteorologist/Air Pollution Specialist;
- Geologist/Soil Engineer;
- Chemist/Water Pollution Specialist;
- Forester/Ecologist; and
- Social Scientist (Geographer).

3.6.1 Land use and conservation

For exploration drilling, the land that is disturbed by road construction, drilling platforms, preparation and storage, and campsite can be quite big and the surface morphology will be changed. With this in mind, the EIA study must identify and assess the impacts related to soil removal and land acquisition and, if needed, introduce mitigations.

Data shall be collected on the ownership of the land, plus the main land use in the area must be identified by mapping agriculture and forestry zones. Land acquisition processes must be learned and then a method for conducting those processes as smoothly as possible must be proposed. Geological formations will be mapped and described. If the project has impacts on protected natural sites, areas of natural interest and/or tourist areas, the EIA identifies the main stakeholders and involves them in the EIA process. A list of required permits that the developer must obtain is included in the project's consent. This information must be clarified in the EAR in text, on maps and with pictures.

3.6.2 Water resource

The developer must identify water bodies and water resources in the area such as lakes, rivers, springs and swamps; critical water points for local communities, like water protection areas, according to the local master plan, must be noted. They must also be shown on a map. The amount of water needed must be listed, both for consumption and for drilling. The site from where water will be taken must be clear, as well as where water pipes will be placed. The amount of waste water must be determined and how it will be treated and disposed of, including both sewage water from camps and drill water with cuttings. If it is necessary to protect the soil in the area from being contaminated by effluents from the project, a detailed description on protection measures is needed.

Depending on the selected water source for the drilling activities, the EIA study must assess the impact of the water abstraction on both surface water and groundwater in the area. This is done by reviewing existing information on the water bodies in the Bugarama area. In addition, a prediction model of the water abstraction, through all seasons and worse case scenarios, must be provided, along with the corresponding mitigations.

3.6.3 Noise

During geothermal drilling, due to the use of heavy machinery and drilling activities, noise is the main impact of the project on the surrounding environment. Various international standards on acceptable noise levels exist, e.g. in the World Bank guidelines, and from the World Health Organization. They must be used as background information to predict the impacts of the drilling work on the local communities. The developer must describe what type of silencers will be used during well testing and inform on expected noise levels.

Simulation models of the noise in the area from different activities such as drilling, testing and bleeding must be prepared. The results must be presented on a map, showing the noise level in various scenarios. The developer must do a background noise level survey in the area and predict the level of noise impacts from different phases of the project on the local community, and how long each phase will last.

3.6.4 Air quality

Information on meteorology and air quality is gathered and used to predict the potential impacts that a project can have on the air quality around the planned drilling sites.

Measurements of the concentrations of the main geothermal gas H₂S from surface manifestations, such as fumaroles and hot springs in the area, can help to predict the steam composition from the well. Information on wind speed and direction, and other meteorological information, needs to be used in a

model of the H₂S dispersion in the area during well testing, both for the worst case and with mitigations. If the necessary data is not available, it must be gathered, e.g. by putting up a mast with necessary instruments to obtain the minimum information.

3.6.5 (Biodiversity) Flora and fauna

The data collection on the existing fauna and flora shall be carried out with an ecological checklist. The results will be shown on maps, showing the distribution of the dominant and rare species of fauna and flora in the area, and the identification of unique habitats of animals. Potential impacts on flora and fauna must be assessed and, if necessary, relevant mitigations introduced.

3.6.6 Social aspects

The impacts on the local communities that the project may have must be mapped: positive impacts e.g. creating work for the local people; and negative, e.g. the need to buy land that will be destroyed by the project or the relocation of people for safety reasons, etc. The EIA study shall collect information on the demographic data in the Bugarama area, and identify administrative boundaries, demography and the main developmental sectors. The study must predict the magnitude and extent of the impact of the project on the local community.

3.6.7 Solid waste

In the EIA process, the solid waste must be clarified and, in the final EIA report, a list will be provided with the different types of waste, amounts, where it comes from, etc. The waste management program will be introduced along with how the developer plans to manage it.

3.6.8 Additional environmental issues

The EIA study should also deal with other aspects of the drilling activities such as natural hazards, tourism, geology, landscape and visual impacts.

The size of this report is limited and so is the time for preparing it; that does not allow as extensive a work as is needed for a good TOR.

The ESIA study is not limited to the above mentioned tasks; more will be added during the tender process for the study and during the selection of the consultants who undertake the work.

3.7 Expected outcome of the EIA study

The EIA study must include possible alternatives in terms of technology, site selection, design and construction techniques, etc. All the alternatives must be compared, taking into account the impacts on nature and society and costs. The EIA must include a no-project alternative and a comparison of all alternatives (including the Zero alternative).

If the accuracy and precision of the EIA report is good, the World Bank guidelines are followed, and the project is well prepared, then the geothermal exploration drilling project should be classified as category B: *If the projects potential adverse environmental impacts on human populations or environmentally important areas are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects.*

In fact, Category B is normally more acceptable than Category A to external sponsors who might be interested in financing further studies in the area.

The main parts of an EIA report are a non-technical summary, the description of the project and the institutional framework in place. But mostly, the report must contain a baseline information and the analysis of the impacts of the project on the environment and the strategies to minimise or avoid the impacts through an ESMP and a Resettlement Action Plan. The proposed time for this EIA study is 60 calendar days.

The environmental impact assessment study of the above mentioned project should constitute, but not be limited to, all the above mentioned methodologies, the scope of work and all reported obligations.

4. PRELIMINARY ENVIRONMENT ASSESSMENT AND MITIGATIONS

4.1 Land use

When geoscientific surveys have been completed and drilling exploration wells is the next step to get further information on the geothermal system, the scientist must choose the sites for the exploration wells. It is normal that, in the beginning, 2-4 sites are introduced in the EIA process. In some cases, the location of the drilling sites is within a densely populated area and it would be necessary to buy the land and move the people. This can be a complicated process as it is necessary to find new land for the people.

Land acquisition is delicate and should, therefore, be carefully planned at an early stage of the EIA process to fulfil national and international regulations considering the main issue in the area, which is land shortage.

The World Bank's policy on involuntary resettlement (OP 4.12) applies to all land acquisition, impact on assets, negative impact on livelihood and/or any changes in access to resources due to a subproject, irrespective of whether or not affected persons must move to another location. This includes the restricted use of resources in a park or protected areas by people living inside or outside the areas which affect their daily lives (ArGeo, 2009).

The land acquisition process should start by complying with the national laws and WB guidelines. In fact, the World Bank's resettlement policy emphasizes some features that may differ from national policies, mainly on compensation costs. Where domestic law does not meet the WB standard of compensation, it is supplemented by additional measures necessary to meet the WB standard (ArGeo, 2009). This can be fulfilled by job opportunities to the people who are directly vulnerable to the project.

4.1.1 Current land use

Among the policies adopted to develop the Bugarama area is the crop intensification policy which facilitates access to national markets and, thus, improves the lives of local communities; this implies that the main land use in the area is agriculture. The main negative impact of a geothermal drilling project on the local community is the loss of farmland.

The drilling locations have not yet been decided but in the final EIA report all the main infrastructure for the geothermal project, and various options for them, if possible, will be shown on detailed maps (1:1000-1:5000) where different land use is shown and the environmental and social impacts are compared in the text. However, in this preliminary assessment, the lack of maps and various data on land use does not allow a detailed assessment of the expected impacts of the project on the land use and people in the area.

4.1.2 Impact on land use

Considering that the Bugarama area is one of the highest populated sectors in the country (1266 p/sq.km), the main impact of the project is the land loss by the local community. Measures to avoid and minimize the negative impacts from that must be explained and discussed in more detail in the final ESIA report.

The project will directly affect the local people as it will destroy agricultural land and private houses. Any kind of activity that affects the local population in this way is considered to be causing involuntary resettlement. The local authorities and the developer have to come to an agreement on how that will be arranged. A program to prepare the process of land acquisition must be made in the beginning of the EIA process and should be made in cooperation with the local authorities, from the district level to the cell level. The program would include meetings where the exploration drilling project is introduced and necessary supporting documents are handed out. The documents would include detailed information on the project. In this phase, how the drilling project fits into the master plan of the area would also be discussed with the local authorities. At a later stage, when more information has been collected and the impacts of the drilling project in the area are clearer, more meetings and a public hearing should take place. All the comments collected from the local authorities and the public shall be used in the EIA process and also at the later planning and project design level of the project.

A Resettlement Action plan (RAP) must, therefore, be presented in the final EIA report, containing specific and legally binding requirements to be abided by, to resettle or compensate before the project is given a consent and its implementation begun.

At the national level, existing land laws define the regulations and requirements to be complied with in case of land acquisition. In fact, the Organic Law N° 08/2005 of 14/07/2005 determines the use and management of land in Rwanda. It states that any land without the boundaries of towns and municipalities established by law, or presidential order, is rural land.

The expropriation law on public interest: N°18/2007 of 19/04/2007 (Republic of Rwanda, 2007), presents the rules to be followed during land acquisition on projects for public interests on behalf of the Government. Research for geothermal energy can be classified as part of the valuable minerals and other natural resources in the public domain (Article 5). In addition, ministerial order N °002/16.01 of 26/04/2010 determines the reference land price outside Kigali city (Republic of Rwanda, 2010).

Another severe impact of the project could be on tourism in this area, which is known for its hot springs, attracting hundreds/thousands of tourists every year. Changes in the hot springs, or access to them, could have negative impacts on work in the tourism sector, but also positive impacts. In the final EIA report, tourism in the area and its value for the community must be described and discussed in detail. That discussion must include different options on how possible negative impacts could be minimised and, if necessary, include relevant mitigations that the developer is ready to provide.

4.1.3 Conclusions

The developer's main goal and the result from the EIA process must be to:

- Avoid any displacements of households;
- Minimize space needed for the infrastructure such as drilling platforms and new roads;
- Choose the areas which are least suitable for agriculture;
- Use existing road tracks;
- Avoid disturbing sensitive geothermal manifestations; and
- Avoid areas which are tourist attractions.

It is most likely that some residents must be moved. However, from experience during Karisimbi exploration drilling, positive impacts also come with the project. Some of them are:

- Temporary employment that contributes to poverty reduction, especially if vulnerable local people such as farmers with limited land are employed;
- Improved infrastructure with rebuilt roads. In fact, Rusizi is a rural area so there are few public infrastructures, especially roads. Inadequate roads raise transport costs, which forces poor people to sell and purchase at local markets and increases unemployment;
- The geothermal exploration project created opportunities for businesses, both directly and indirectly related to the project, and contributed to a local increase in commerce activities; and
- Improved roads might improve tourism in the area for those coming to visit the hot springs of Bugarama.

4.2 Solid waste generation and management

Sources of wastes at the drilling site can be divided in two main parts: household waste from the campsites, paper and plastic containers and, secondly, cuttings from drilling and scrap metals.

In the EIA process, the solid waste must be delineated and, in the final EIA report, there will be a list with the different types of waste, amounts and origins, etc.

A waste management program will be introduced, including how the developer plans to manage the waste. That will include:

- Localizing adequate landfills for the disposal of wastes, mainly from households, by checking the master plan of the region and getting the approval of the local authority (district level);
- Control waste from the construction sites (platforms), equipment & workers camp through a Construction Waste Management Plan;
- Put in place a grade & sort waste management system to manage garbage and other forms of waste generated;
- Environmental education for the workers and people living in the worker's camp, as well as the people operating food kiosks, on proper waste management practices. The main idea of the program is to show people the importance of good management of hazardous materials and also the importance of separating different types of waste. Tidiness on the platform can also be a part of reducing the risk of accidents. Immediately, SWMP to be developed by / communicated to contractors;
- Consider possibilities of waste reduction, reuse and recycling, especially paper and plastic containers that can be recycled by the local community;
- Carry out periodic environmental audits that also cover waste management;
- Inspection of drill site and campsites; and
- Identify measures for minimisation of waste generation and safe disposal of construction, operation and decommissioning wastes. This will include all hazardous substances used and produced during the Project, controlled by a Material Safety Data Sheet (MSDS). The chemical composition of the drill cuttings needs to be analysed and, if there are no chemicals (like arsenic) that can pollute the environment, the cuttings will be buried on the site of the drilling platform. Otherwise, the cuttings must be taken to an adequate landfill.

In the last section, some mitigating measures to be adopted will be introduced.

4.3 Noise

4.3.1 Sources of noise during geothermal exploration activities

Most likely the drilling will take place in forests and rural areas so the noise during drilling activity will mainly affect people living in proximity to the drilling.

The main sources of noise can be divided into two groups. The first one is noise from construction work, during site clearance for the platform, the layout of pipelines, building the campsite, and road reconstruction. All these need the presence of heavy machinery which cause noise, affecting the closest receptors and maybe at some distance. In addition, traffic on the road is expected to increase during construction and drilling.

The second and the one that can have the most negative impacts, is the noise from the drilling activity. That is temporary, 6-8 weeks, and rarely exceeds 90 dB (A). The noise from discharging boreholes may exceed 120 dB (A) (Kristmannadóttir and Ármannsson, 2003). Table 7 shows the main source of noise and the noise levels of different operations at the rig site when drilling.

TABLE 7: Noise from some drilling activities (Hunt, 2001)

Activity	Noise level (dBA)
Air drilling	120 (85 with suitable muffling)
Discharging wells after drilling	Up to 120
Well testing	70-110 (if silencers used)
Heavy machinery	Up to 90
Well bleeding	Up to 85 (65 if rock muffler is used)
Mud drilling	Up to 80
Diesel engine to operate compressors and electricity	45-55 (if suitable muffling is used)

Drilling a well may take 6-8 weeks, depending on the depth of the well, difficulties during the drilling, and pumping at the end. How long the effect will last is dependent on the number of wells to be drilled and later tested, and whether they will be tested one after another or many at the same time.

During well testing, liquid and vapour flow directly into the silencer which reduces noise. The silencer can be of different types and will be described in the final EIAS. Estimates indicate that noise from the hole in well testing is in the range of 70-110 dB (A) at the platform. Commonly, 200 m away from the borehole during testing, the noise level goes down to 60 dB (A) and at 500 m down to 50 dB (A). It can be expected that the limits of 40 dB (A) noise levels are achieved within 1,500 m (VSÓ, 2013). This can take 1-2 months, but bleeding can last for years.

Since the area is highly populated, the disturbance from the noise will mainly affect people working and/or living within 500 m radius. However, this impact is temporary as explained before. In the final EIAS, the noise dispersion model will be shown and that will take into account the vegetation and landscape barriers in the area around individual wells.

There are no known standards, guidance or legislation applicable to environmental noise in Rwanda. However, international regulations can be applied such as WBG EHS General Guidelines on Noise Management. Environmental, Health, and Safety Guidelines for Geothermal Power Generation can be used as guidelines. Table 8 presents the World Bank and World Health Organization noise exposure standards.

TABLE 8: World Bank and WHO noise exposure standards, (WB, 1999; WHO, 1999)

Receptor	Maximum allowed Leq (hourly) in Db(A)			
	World Bank		World Health Organization	
	Day time (07:00-22:00)	Night time (07:00-22:00)	Day time (07:00-22:00)	Night time (07:00-22:00)
Residential institutional and educational	55	45	50	45
Industrial and commercial	70	70	85	85

*Leq is the equivalent continuous sound pressure level

4.3.2 Mitigating measures

To meet requirements on noise levels, mitigating measures must be taken in order to avoid noise impacts both day and night in residential areas (nearest households). These could be:

- When siting and designing the project, take advantage of the natural topography and vegetation as a noise buffer;
- During drilling and well testing, reduce noise by using silencers, and rock mufflers;
- Conduct regular noise monitoring every month at the same locations: in the closest sensitive location such as households, school, health centres, during drilling and critical operations such as air drilling; and
- Conduct regular meetings with the local community to record complaints about noise from the drilling activities.

5. CONCLUSIONS

In this report, the main factors of geothermal drilling for both exploration and production purposes were described. It involves civil work that consist of roads construction, water supply installation, worker's camp, storage yard, preparation of drilling pads and the drilling itself. If the exploration wells are not used as production wells or the platforms used for further drilling, they will be demolished and that must be part of the EIA. The above mentioned works affect the environment and the public's land use, water resources, air quality and noise. The effects can also affect the biodiversity and local people in the project area. The TOR is prepared to serve as a guideline for a future EIA, addressing the environmental and social issues that might arise from drilling activities specifically in the Bugarama area.

The preliminary TOR was prepared to give an example so that future EIA studies in the Bugarama area are conducted in accordance with national laws and international requirements. Surface studies in Bugarama were launched in 2014 and will be finalize by drilling 1400 to 1800 m wells to assess the available resource. Based on experience gained during drilling in Karisimbi, the TOR presents the main issues that need to be included in the ESIA study. It also gives an idea of the assessment methodology, and how the results must be presented. The TOR is not definitive, due to the lack of information on the results of the surface studies and information on where the exploration wells are planned to be located. Therefore, the area of influence is not known and the preliminary TOR must be looked at as a tool to be used for the final TOR for the ESIA study.

The laws, EIA framework and procedures in Rwanda provide the main tasks that need to be undertaken in order to fulfil the requirements to obtain the certificate of authorization for geothermal exploration

drilling. On the other hand, international requirements, such as the World Bank policies, provide complementary guidelines on the assessment of environmental issues of the drilling activities that are not addressed in the national law, such as noise, but also include the major requirements for projects to be funded by the WB.

However, the preliminary EIA of the project showed that the project will have the most impact on three environmental factors. Those are land use, noise and the generation and disposal of solid waste. It showed that land acquisition for the project is a delicate procedure. The Bugarama area has a high population density so there is a scarcity of land available for agriculture. The most important mitigations are to avoid displacements of households and minimize the space needed for the infrastructure, such as the platform and new roads. It is also important to choose areas which are least suitable for agriculture, use existing road tracks and avoid disturbing sensitive geothermal manifestations and tourist attractions. As there are no national guidelines on noise, the World Bank and WHO policies must be followed during drilling activities, and monitoring must ensure that the level of noise is acceptable, both for the workers and neighbouring communities.

A more comprehensive EIA must be done for geothermal exploration drilling in the Bugarama area.

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